

NAVY AREA THEATER BALLISTIC MISSILE DEFENSE (NATBMD)



Navy ACAT ID Program

Total Number of Systems:	1,500 missiles
Total Program Cost (TY\$):	\$6710M
Average Unit Cost (TY\$):	\$2.4M
Full-rate production:	3QFY03

Prime Contractor

Raytheon Missile Systems Company
Lockheed Martin Naval Electronics &
Surveillance Systems (AEGIS systems)

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

The Navy Area Theater Ballistic Missile Defense (NATBMD) system is intended to minimize the vulnerability of U.S. forces and population areas against the theater ballistic missile threat. The mission of NATBMD is to protect amphibious assault forces and coastal cities from short to medium-range ballistic missiles without degrading current Standard Missile capabilities against manned aircraft and cruise missiles. The NATBMD system contributes to three of the four *Joint Vision 2020* operational concepts: *full-dimensional protection, precision engagement, and dominant maneuver*. Navy Area supports:

- *Full-dimensional protection* by defeating incoming short and medium range ballistic missiles to assist in controlling the airspace.
- *Precision engagement* by contributing to a Theater Ballistic Missile Defense (TBMD) family of systems that can locate TBMD targets, provide command and control, engage targets, and assess level of success.
- *Dominant maneuver* by the application of information, engagement, and mobility capabilities to accomplish a lower-tier TBMD defense.

The NATBMD system consists of the following:

- Standard Missile-2 (SM-2) Block IVA, which incorporates an infrared seeker, a radio frequency adjunct sensor, forward-looking predictive fuze, and an improved auto-pilot to the proven Block IV airframe.
- Upgrades to the AEGIS Weapon System to enable tracking and engagement of high-speed, low radar cross-section, theater ballistic missiles (TBMs).
- Upgraded Link 16 message set that provides interoperability with Navy, other Service theater ballistic missiles defense systems, and command and control systems.

BACKGROUND INFORMATION

The NATBMD system entered EMD in March 1997. Program Demonstration and Risk Reduction (PD&RR) activities have been reported in previous annual reports and will not be recounted in this year's report. EMD flight testing commenced at the White Sands Missile Range (WSMR) in June 2000.

Prior to Milestone III and fleet introduction, the Navy originally planned to deploy an interim theater ballistic missile defense capability called LINEBACKER. Although still planned as a development phase of the program, this capability has now been defined by the user as an engineering, development and risk-reduction effort in support of the fully capable, tactical objective system. LINEBACKER ships and computer program permit early involvement of fleet users in system testing and integration. LINEBACKER ships have either a theater ballistic missile defense capability engaging unitary targets only *or* an anti-air warfare capability. The objective system will be able to engage all threats (unitary and separating) simultaneously. LINEBACKER is limited by a reduced track filter capability and physical separation constraints for object resolution, all of which contribute to a smaller defended footprint compared to that of the objective system. The LINEBACKER system consists of a LINEBACKER version of the AEGIS Weapon System software installed on two cruisers. Thirty-five EMD/LINEBACKER test missiles will be procured. Twenty-five of the 35 LINEBACKER missiles will be used in at-sea testing during DT/OT and OPEVAL, with the remainder used for other testing.

TEST & EVALUATION ACTIVITY

The NATBMD TEMP was approved in February 1997 and is currently undergoing revision. The TEMP includes the complete test matrix for LINEBACKER, DT, and OT. Modifications to the OT flight test matrix are in place as part of this TEMP revision. The EMD phase of testing will examine performance against ballistic missiles, aircraft, cruise missiles, multiple targets, and debris and countermeasures environments. Supporting the FY03 Milestone III decision are four major test phases:

- FY00-FY02: DT/OA consisting of eight missile firings at WSMR against surrogate TBM and cruise missile targets (without the AEGIS/SPY-1 Radar).
- FY02: At-sea tests consisting of three missile firings against threat-representative targets at the Pacific Missile Range Facility (PMRF), Kauai, HI. These tests will be the first to utilize the fully integrated AEGIS/SPY-1 radar and SM-2 Block IVA missile.

- FY02: 1998 Iranian Missile Protection Act (IMPACT 98), a test mandated by Congress to determine the capability of lower-tier Ballistic Missile Defense systems against medium-range ballistic missile threats. The test will consist of a target tracking event for characterization and a single Block IVA firing against a long-range target at Kwajalein Atoll.
- FY02-03: Twelve DT and thirteen OT firings at PMRF against real and surrogate TBMs and cruise missile targets.

In FY00, the Navy began the DT/OA series of flight tests at WSMR with two Control Test Vehicle tests (CTV-1 June 2000 and CTV-2 August 2000). The firings were conducted without a target to gather data on the performance of the upgraded autopilot and modified airframe of the SM-2 Block IVA. Both tests successfully demonstrated the planned response and performance of the autopilot and airframe. The successful completion of both shots satisfies exit criteria for long-lead component procurement to support SM-2 Block IVA LRIP. The commencement of intercept flight testing at WSMR is currently scheduled for 4QFY01.

The LINEBACKER system, deployed onboard USS LAKE ERIE (CG-70) and USS PORT ROYAL (CG-73), has generated tremendous value-added to the overall Naval TBMD development process. Recently, the Chief of Naval Operations removed USS LAKE ERIE from its battle group and declared her a dedicated TBMD test asset. During the past year, LINEBACKER ships have participated in a wide range of joint exercises, including Slugger in 3QFY99, the Theater Missile Defense Critical Measurements Program-3A (TCMP-3A) in 4QFY99, and Pacific Blitz in 3QFY00. These exercises demonstrated the ability of LINEBACKER ships, operating in TBMD stand-alone mode, to detect and track non-separating TBMD targets and cue other sensors and TBMD systems. However, LINEBACKER has yet to perform a live SM-2 Block IVA engagement against a TBM target.

For at-sea system testing in FY01, using the LINEBACKER system, the Navy plans to employ one Lance and two Short-Range Air-Launched Targets (SRALTs). SRALT is the only existing mobile target available to the Navy Area program. However, at present, SRALT suffers from two main deficiencies: (1) the infrared signature of SRALT is not threat-representative; and (2) the downrange accuracy of SRALT does not meet the requirements needed for Navy Area testing. Contractor recommendations for improving SRALT endpoint accuracy and threat infrared signature representation were submitted as part of a government-sponsored review. In 3QFY00, a contract for procurement of SRALT vehicles was awarded which should address SRALT shortfalls.

The NATBMD LFT&E strategy for static warhead arena tests, dynamic warhead sled tests, direct hit sled tests, flight tests and other ancillary tests and simulation analyses was approved by DOT&E in August 1996. DOT&E approved the test plan for the SM-2 Block IVA warhead arena tests in November 1997. Phase I arena testing concluded in April 1998. DOT&E approved the test plan for dynamic warhead sled testing in July 1998. Phase I warhead sled testing was conducted at the Holloman AFB High-Speed Test Track in Alamogordo, NM, from July 1998-January 1999, with the test warheads flying at approximately 5,000 ft/sec. A dynamic warhead sled test report was published in June 1999. Warhead sled testing was followed by a direct-hit sled testing series in late 1999. A total of three tests were carried out at Holloman AFB, with the missile surrogates flying at approximately 4,000 ft/sec. Based on the successful results of those tests, the Phase II direct hit sled test series was cancelled and the targets were allocated to other lethality tests. Phase II warhead arena test series included one warhead arena test and two fragmentation mat projector tests against high-explosive targets. The test series was completed in January 2000. The direct-hit sled test series included:

- Direct-Hit Sled Test-2A (DST-2A). On August 26, 1999, the Navy fired an SM-2 Block IVA surrogate against a TBMD nuclear payload replica designated as the SRNT. The target was defeated.
- Direct-Hit Sled Test-1B (DST-1B). On October 5, 1999, the Navy fired an SM-2 Block IVA surrogate against a CSM target. The target was defeated.
- Direct-Hit Sled Test-2B (DST-2B). On December 2, 1999, the Navy fired an SM-2 Block IVA surrogate against a TBMD nuclear payload replica designated as the GRNT. The target was defeated.

Phase II warhead sled testing was conducted through November 2000, with the test warheads flying at approximately 5,000 ft/sec. The warhead sled test series was supplemented by a fragmentation mat projector test series. The remaining lethality information will come from flight testing. The warhead sled test series included:

- Warhead Sled Test-6B (WST-6B). On March 23, 2000, the Navy fired an SM-2 Block IVA test warhead against a TBMD nuclear payload replica designated as the GRNT. Preliminary indications are that the target was defeated. Further detailed evaluation is underway.
- Warhead Sled Test-5B (WST-5B). On August 2, 2000, the Navy fired an SM-2 Block IVA test warhead against a sight classified, high interest TBMD nuclear payload replica designated as the Re-entry Body Ballistic Target (RBBT). Preliminary indications are that the target was defeated. Further detailed evaluation is underway.
- Warhead Sled Test-3 (WST-3). On August 31, 2000, the Navy fired an SM-2 Block IVA test warhead against four TBM-payload targets, featuring a demonstration of the Bulk Chemical Replica flight test target sensor and instrumentation package that will be used in WSMR DT flight testing. The warhead did not detonate as planned, resulting in a no-test. The test was repeated successfully on November 1, 2000.

The warhead sled test series was supplemented by fragmentation mat projector tests in FY00. The remaining lethality information will come from flight testing.

TEST & EVALUATION ASSESSMENT

The Navy, AEGIS, and Standard Missile contractors have a long history of evolutionary development of the AEGIS and the Standard Missile systems. However, the Navy has yet to demonstrate via live testing, an integrated system (AEGIS and Standard Missile) capable of acquiring, tracking, and intercepting theater ballistic missiles. The PD&RR phase and LINEBACKER test events have demonstrated that the AEGIS SPY-1 radar can track a theater ballistic missile and, in a separate test, an early prototype version of the SM-2 Block IVA demonstrated that it could engage and intercept a Lance target using guidance data from White Sands Missile Range tracking instrumentation. A number of technical risks and challenges exist. They include:

- Forward Looking Fuze (FLF): The FLF detonates the SM-2 Block IVA warhead at the optimal time to strike the TBM in the payload section. The FLF is unique to the Block IVA

and is required to meet the stressing engagement timeline and lethality requirements of TBMD. For the FLF, the Navy must verify slaving the radar tracker to the infrared seeker, real-time processing data fusion, and burst time accuracy to achieve desired warhead effects at the proper location on the target.

- **Infrared Seeker Dome Cooling System (DCS) Redesign:** During the PD&RR flight, the infrared seeker experienced an aero-optical high-background noise anomaly that was most likely caused by contamination of the seeker dome by the DCS. The design of the DCS was consequently modified. Although tested in the wind tunnel, the modified DCS has not been flight tested.
- **AEGIS Weapon System Computer Program Complexity:** The AEGIS system may have difficulties maintaining both ballistic missile and anti-air warfare missions given the high radar loading levels required for multiple, high-speed, low radar cross-section theater ballistic missile targets.
- **Linear Search and Track Processor (LSTP) Development:** The LSTP is an adjunct processor that improves the object resolution and detection range of the AEGIS radar. This processor is required for resolving closely spaced objects at long-range, such as separating re-entry vehicles.
- **Target Discrimination:** For certain threats, objects such as booster tanks and attitude control modules can exhibit discrimination characteristics that resemble those of the target payload vehicle. This poses a particular challenge to the system's discrimination capabilities and protocol. For such cases, robust primary and secondary means of discrimination are required that can identify the target for all TBMs in the NATBMD ORD defined threat set. To properly understand the NATBMD system's capabilities and limitations relative to this discrimination challenge, and to assess effectiveness and suitability, a robust modeling and simulation effort anchored by appropriate flight-testing must be developed and executed. Such a robust testing effort is currently not planned and will require additional test assets and funding.

In 1998, utilizing lessons learned from the Welch Panel on Ballistic Missile Defense, two risk reduction flights were added to the WSMR flight test schedule. These risk reduction flights were intended to address the Forward Looking Fuze and Dome Cooling System technical risks identified above. However, following a program re-baseline in FY99-00, a risk-reduction flight to test modifications to the infrared seeker DCS was dropped, and the test objectives were moved to CTV-2. On account of technical delays to the start of DT/OA flight testing in FY99-00, the Navy has since deferred testing of the DCS to the third DT/OA shot (the TBM Fly-By mission). This delays DCS flight testing and risk mitigation pertaining to the unresolved aero-optical background anomaly. The schedule changes have also increased the significance and risk of the TBM Fly-By test and the TBM-1 test, which will be the first in-flight test of both the DCS and the FLF.

Along with the DT/OA Target Fly-By mission and TBM-1 mission, FLF mitigating actions include a series of ground-test experiments from FY97-FY01. The most recent and comprehensive tests include miss-distance measurements using artillery shells and an integrated Block IVA guidance section. The FLF ground experiments to date have provided valuable risk reduction to evaluate FLF performance before DT/OA testing. However, because ground tests alone cannot fully assess the adequacy of FLF

hardware to meet the fuze timing requirements, the FLF will remain a program risk item until it is fully flight qualified and tested.

The size and complexity of the AEGIS Weapons System computer program is significantly greater than in any previous AEGIS Weapons System baseline. To reduce the risk, the Navy has re-phased code development, added testing, simplified the AEGIS display system, and utilized commercial-off-the-shelf vendor technical support. Likewise, the risk associated with the completion of the SPY and LSTP element integration and testing has prompted the Navy to de-scope non-essential requirements and increase integration and testing time. In spite of these adjustments, the progress of development and testing of the AEGIS Baseline 6 Phase III software (TBMD Tactical objective software build) is lagging projections but does not yet impact DT/OT test schedules. The complexity of the undertaking may have been underestimated.

The challenges associated with target discrimination may limit the NATBMD system's ability to counter all existing and near-term threats referred to in the Navy Area Operational Requirements Document. To address DOT&E's concerns in this area, testing designed to evaluate the discrimination capability of the Navy Area system will have to be added to the revised TEMP. The test will evaluate both the primary and secondary means of discrimination for the Navy Area system against threats identified in the ORD.

The interoperability requirement from the Navy Area program Operational Requirements Document is Link-16 capability. The Navy, during its TBMD exercises, routinely establishes a Link-16 network with other TBMD nodes (PATRIOT and THAAD) either via gateways or over-the-air. These early networks have proved valuable to the Link 16 message verification process and have provided worthwhile training opportunities for all TBMD players.

Ballistic missile target verification, validation, and accreditation are a concern. Pending modifications to SRALT should satisfy the Navy Area target requirements for LINEBACKER at-sea testing, but the time required to develop and procure threat-representative targets for future flight test phases may not support the existing schedules. Sufficient funding to permit the initiation of operationally realistic target build and purchase is also at issue. The T&E community is working with the Navy and BMDO to resolve these target issues.

CONCLUSIONS, RECOMMENDATIONS AND LESSONS LEARNED

Notwithstanding the aforementioned risk areas, the program is technically solid. There are several remaining issues that could challenge the development and test schedule.

- Continued compression of the DT/OA flight test schedule has curtailed the risk-reduction activities associated with each test and may ultimately delay the flight test schedule itself.
- The missile and AEGIS development programs must both proceed without significant difficulties to maintain a tight schedule. Based upon developments this past year, neither of these seem capable of maintaining schedule.
- The development and procurement of the target surrogate set must progress at an aggressive pace to satisfy threat-representative target requirements and meet the flight test schedule.